1,119,699

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Inlet and Distribution Device for a Liquid/Vapour Mixture

We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V., a company organised under the Laws of the Netherlands, of 30 Carel van Bylandtlaan, The Hague, the Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to an inlet and distribution device for a liquid/vapour mixture in distillation columns or other treating zones.

In the chemical and petrochemical industries it is often the case that mixtures of liquids and vapours have to be transferred from a given treatment zone to a subsequent treatment zone, as for example in distillation processes. In this case the product to be distilled is fed into a generally vertical distillation column at a point between the top and the bottom of the column and may consist of a liquid/vapour mixture. In modern installations having a large capacity and throughput the supply velocites of such mixtures are generally very high; these high supply velocities may be disadvantageous for the distribution of the product to be treated over the column cross-section of the column into which it is fed.

It is in fact desirable, particularly in distillation processes, for the vapour phase and the liquid phase to be separated as much as possible immediately after entering the column and for each phase to be separately fed to the adjacent tray while being as well distributed as possible over the column section. If no special measures are taken it will not be possible to effect a proper separation of a mixture fed into the column at a very rapid rate since the feed will then strike the wall situated opposite the inlet with excessive force, and whilst the vapours subsequently rise in the column they also entrain a large portion of the liquid phase with them. The portion of the liquid which has not been entrained flows for the most part downwards near the column wall situated opposite the inlet, which means that in those cases where it is desired to distribute the liquid regularly over the tray situated below the inlet this object likewise remains unachieved. Moreover, the life of the structural material of the column may be adversely affected by the strong impact of a liquid/vapour stream, so that measures generally have to be taken to provide local protection for the column wall.

It has already been proposed to overcome the above drawbacks by arranging a liquid/vapour cyclone separator in the column in which liquid and vapour are substantially separated and are moreover each independently introduced axially into the column. Cyclones of this type require a considerable amount of space in view of their generally large capacites and they are frequently the controlling factor for the diameter of the column in question, so that the latter is larger, at least locally, that when no cyclone has to be introduced. This means, therefore, that considerably higher column building costs are inevitable.

The object of the present invention is to provide an inlet and distribution device for liquid/vapour mixtures, which is of cheap and simple design, which can be incorporated in columns and treating zones of all types and shapes, and which is not only capable of previously separating the liquid and vapour phases from each other, and distributing them, but is also able to ensure substantially uniform distribution over the cross-section of the column or treating zone of the already separated phases.

To simplify the specification and claims only the word "column" will be used hereinafter, but this does not mean that the invention can only be used in equipment of this type. The invention may equally well be employed in any treating zone in which it is desired to effect at least limited separation of the liquid and vapour in a mixed feed stream.

According to the present invention an inlet and distribution device for a liquid/vapour

mixture in columns comprises a number of curved guiding vanes placed one behind the other within the column or similar apparatus, the leading end of each vane making a sharp angle with the direction of the main flow of the mixture entering the column, in such a way that each vane intercepts and deflects part of the mixed feed stream, and is capable of effecting a separation between liquid and vapour by inertia and centrifugal force, the vanes together forming a series, the vanes of which are placed at such a distance from each other that a substantially uniform distribution of liquid and vapour is obtained over at least that part of the column cross-section across which the series of vanes extends.

The series of vanes is preferably arranged inside the column in the extension of the centre line of the mixed feed inlet which is connected to the column. The most favourable arrangement is thereby obtained for intercepting and deflecting part of the feed stream on each vane.

The vanes in the series can be bounded at the side by a wall with the result that it is not possible for part of the feed stream to flow past the sides of the vanes. The main effect of this is to prevent part of the feed stream from escaping liquid/vapour separation and to prevent too much liquid from being entrained by the vapour. For the same reason preferably at least the vanes in the series which are situated directly behind the feed inlet of the mixed feed stream have a greater width than the effective diameter or width of the feed inlet to which the series of vanes is connected.

According to a preferable feature of the invention each vane preferably makes an angle at the inlet end with the direction of the main flow of the mixed feed stream, which angle, however, amounts to not more than 10°. An angle, albeit small, between the vanes at the inlet side and the direction of the main flow of the feed stream has particular advantages because on the one hand unwanted pressure drop is caused when too large a vane angle is chosen while on the other hand when too small a vane angle is chosen the total passage of the feed stream is needlessly reduced.

In general the mutual distance between the vanes, measured on their outlet ends is preferably kept within certain limits. This distance is preferably not less than 5 cm and not more than 40 cm, preferably approximately 10 cm. These dimensions are substantially independent of the size of the device, and consequently they will also determine the number of vanes which are situated in the series.

In one embodiment of the invention the vanes are arranged in such a way that they all deflect the mixture feed stream to one side, the space on the other side of the vanes being bounded by a wall which is connected to the side walls so that a box-like arrangement is obtained, one side of which is formed by a series of vanes, which box-like arrangement is connected to the feed inlet. The series of vanes can in this case have a downwards direction, so that the liquid phase flows down in a number of streams into the tray below, or collects directly in the bottom part of the column. It is, however, also possible to positon the box arrangement differently, for example in such a way that the vanes deflect the stream to the side. If a box arrangement of this type is present in a cylindrical column the liquid streams will generally strike the column wall before flowing downwards along the wall. A particular advantage in this embodiment is that the streams which are intercepted and deflected near the column wall, and are thus travelling at maximum speed when they strike the column wall, will do so at the most favourable angle.

In another embodiment of the invention the vanes are arranged in pairs opposite each other so that each pair deflects part of the feed stream towards two opposite sides, the vanes forming together with the side walls a box-like arrangement two sides of which are provided with a series of vanes, which box-like arrangement is connected to the feed inlet. In this embodiment the box arrangement is generally arranged in the column in such a way that the mixture feed stream is deflected to the sides.

It can happen, for example at very high rates of flow, that too large a part of the liquid is nevertheless entrained by the vapour stream, for example as a result of reatomisation on the outlet side of the vanes, and this can be prevented according to the invention by providing the vanes in the outlet side with a liquid collecting channel which is equipped at a suitable point with a liquid discharge opening or other liquid discharge device. In this case the liquid collecting channels can have a constricted passage on the inlet side.

The invention may be carried into practice in a number of ways but certain specific embodiments will now be described by way of example with reference to the accompanying drawings in which: —

Figures 1 and 2 show diagrammatically a part of a vertical column, in horizontal and vertical cross-section respectively, in which a device according to the invention is arranged;

Figure 3 shows a perspective diagram of the embodiment of the device according to the invention as arranged in the column shown in Figures 1 and 2;

Figures 4 and 5 show cross-sections of two other embodiments of a device according to the invention, arranged in cylindrical columns and

Figure 6 shows a detail of a vane provided at the outlet side with a collecting channel.

Figures 1 and 2 show the column wall 1 of a vertical column, for example a distillation column. This column is provided at the side with an inlet 2 for a mixture consisting of

liquid and vapour. Behind this inlet, viewed in the direction of flow of the mixture, are situated a number of vanes 3; each of these vanes intercepts part of the feed stream and deflects it. In this embodiment the stream is deflected downwards. The vanes are bounded at their sides by walls 4 and 5 while a top wall 6 is also provided so that a box-like arrangement is formed which is provided on its under side with a series of vanes. A perspective diagram of this box arrangement is shown in Figure 3.

The first vane, i.e. the one nearest the feed inlet is so arranged in the mixed feed stream that it intercepts and deflects part of the latter, while the remaining part of the feed stream continues through the separation device. This remaining part meets successively the subsequent vanes each of which intercept and deflect a portion of the feed stream; the leading edge of each subsequent vane is offset from the one before so that the stream becomes steadily smaller until it is finally caught and deflected by the last vane.

Since the vanes have a curved shape the consequence of the inertia and centrifugal force is that the liquid particles strike the vane surface, and that a separation between liquid and vapour is simultaneously effected. The liquid collects to a considerable liquid stream which, after leaving the vane, flows downwards for example, if the vanes face downwards, or is intercepted by an extra wall, for example the column wall, which is the case when it is deflected sideways by the vanes, and is subsequently passed to the tray immediately below. The separated vapour can easily rise in the column. Since the liquid phase has united on the vanes to a continuous stream, this liquid phase is no longer entrained by the vapour stream in the form of small droplets or mist.

Figure 4 shows another embodiment in which a column 11, having a side inlet 12 is provided with a bilaterally operating device according to the invention. Two series of vanes 13 and 14 are arranged in pairs opposite each other in such a way that the feed stream is deflected to the sides in two directions. The vanes are united into a box arrangement by means of a bottom plate 15, and a top plate (not shown in the drawing). The presence of a bottom plate is not necessary in all cases; it is, for example, also possible to provide vanes in the bottom as well, so that a combination is formed of the embodiment of Figure 2 and that of Figure 4.

The embodiment according to Figure 5 shows a design which is simlar to that of Figure 4, but in which a column 21 having a side inlet 22 is provided with a distribution device which is interrupted in the column. This may be desirable in some cases when there is a local obstacle within the column. The box-like arrangement according to Figure 5 consists of two series of vanes, viz. 23 and 24, 25 and 26. In this embodiment the bottom plate 27 is shown as continuous, which is also the case with the top plate (not shown). This design is suitable for use in a distillation column; in the latter case obstacles are provided in the centre of the column by two liquid discharge devices 28 and 29, and it is not desirable for the stream to pass along these liquid discharge devices, or to strike against vertical parts thereof. If desired, the central section of the box arrangement i.e. where the bottom and top plates are continuous, can likewise be provided at the side with a closed plate part so that the central section forms a completely closed box-like arrangement. It will be apparent that in this embodiment it is again not necessary to keep at least the bottom plate completely closed in all cases.

The embodiments discussed above represnt only a few examples out of many possibilities. It is naturally also possible to have the distribution device cover only a part of the entire column diameter so that the last vanes are then situated at a point which is still some distance from the column wall opposite the inlet. A design of this type may, for example, be attractive, if a liquid discharge device is present directly opposite the side inlet, for example in distillation columns.

It is equally possible to have the distribution device cover only a part of the column remote from the wall through which the feed line extends, in which case the feed line extends to within the column. A design of this type is suitable when an obstacle is present near the mixed feed inlet, for example, as described with reference to the design according to Figure 5.

The box-like arrangements can also have a different cross-section, as seen in the direction normal to the centre line, from those described in the above examples. The arrangements may, for instance, also be cylindrical, so that the vanes can then extend over any desired part of the cylindrical circumference, and if necessary can continue the whole way round, with the result that a series of continuous, trumpet-shaped vanes, placed one behind the other is formed.

Finally, Figure 6 shows on a large scale a vane which is provided on its outlet end with a collecting channel. For this purpose a channel-shaped element 32 is secured to a vane 31, which element is provided in this embodiment with an inlet 33, which is constricted relative to the actual catching space 34. Both in the channel and in the vane there are suitable apertures 35, 36 for securing the channel to the end of the vane, for example by means of a bolt. A spacer ring 37 is provided as is customary in such designs. The catching channel shown in this example possesses no end walls, so that the liquid which is caught can flow off at the sides. It is, however, also possible to provide these channels with end walls,

a discharge opening of suitable dimensions being provided at a suitable point if required, or for example in applications where separation of liquid is the main object, to connect a suitable discharge pipe to each channel.

A liquid catching device can also be constructed in another manner, for example by designing the outlet end of the vanes with a double wall, and introducing slots or openings in that part of the wall along which the liquid is passed.

WHAT WE CLAIM IS:—

1. An inlet and distribution device for a liquid/vapour mixture in columns or other treating zones, comprising a number of curved guiding vanes placed one behind the other within the column or similar apparatus, the leading end of each vane making a sharp angle with the direction of the main flow of the mixture entering the column, in such a way that each vane intercepts and deflects part of the mixed feed stream, and is capable of effecting a separation between liquid and vapour by inertia and centrifugal force, the vanes together forming a series, the vanes of which are placed at such a distance from each other that a substantially uniform distribution of liquid and vapour is obtained over at least that part of the column cross-section across which the series of vanes extends.

2. A device as claimed in Claim 1, in which the series of vanes is arranged within the column in the extension of the centre line of a mixed feed inlet connected to the column.

3. A device as claimed in Claim 1 or 2, in which the vanes in the series are bounded at the sides by a wall.

4. A device as claimed in any one of the preceding claims in which at least the vanes which are situated directly behind a feed inlet of the mixed feed stream have a greater width than the diameter or width of the feed inlet to which the series of vanes is connected.

5. A device as claimed in any one of the preceding claims in which each vane makes an angle of not more than 10° at its inlet end with the direction of the main flow of the mixture.

6. A device as claimed in any one of the preceding claims in which the mutual distance between the vanes, measured on their outlet ends is not less than 5 cm and not more than 40 cm.

7. A device as claimed in claim 6, in which the mutual distance between the vanes, measured on their outlet ends is approximately 10 cm.

8. A device as claimed in any one of claims 3 to 7, in which all the vanes deflect the feed stream to one side, and the space on the other side of the vanes is bounded by a wall which is connected to the side walls, a box-like arrangement being thus formed which is provided on one side with a series of vanes and is connected to the feed inlet.

9. A device as claimed in any one of claims 3 to 7 in which the vanes are arranged in pairs opposite each other, so that each pair deflects part of the mixed feed stream towards two opposite sides, the vanes forming, together with the side walls, a box-like arrangement two sides of which are provided with a series of vanes, and connected to the feed inlet.

10. A device as claimed in any one of the preceding claims in which the vanes contain on the outlet end a liquid catching channel provided with a liquid discharge pipe.

11. A device as claimed in claim 10, in which the liquid collecting channels possess constricted passageways on their inlet sides.

12. A method for feeding a liquid/vapour mixture to a distilling column and subsequently separating and distributing the liquid and vapour over the column, the mixture being passed through a device as claimed in any one of the preceding claims.

13. An inlet and distribution device for a liquid/vapour mixture in columns or other treating zones, substantially as described herein with reference to Figures 1 to 3 or Figure 4 or Figure 5 with or without the modification of Figure 6.

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Chartered Patent Agents,
Agents for the Applicant.

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1119699 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

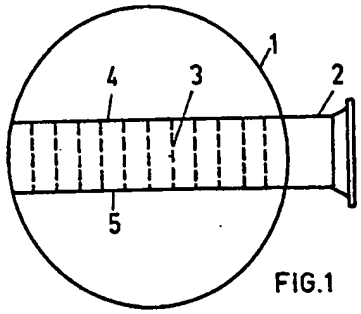

FIG.1

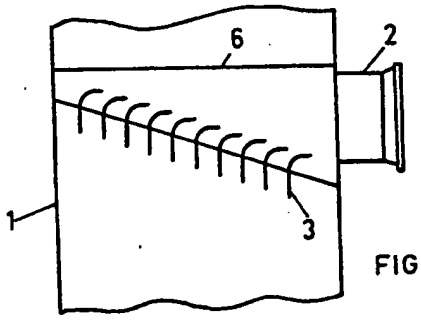

FIG.2

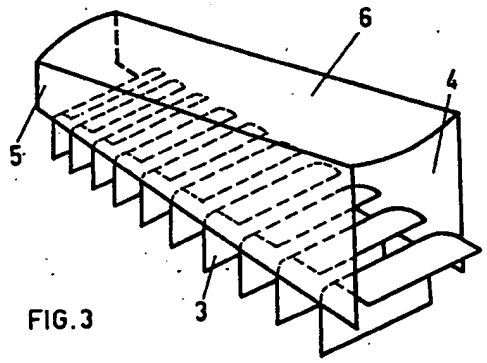

FIG.3

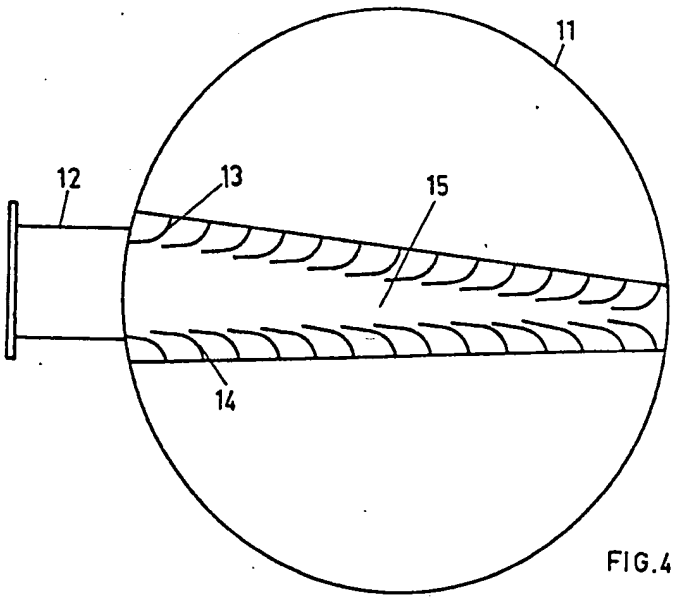

FIG.4

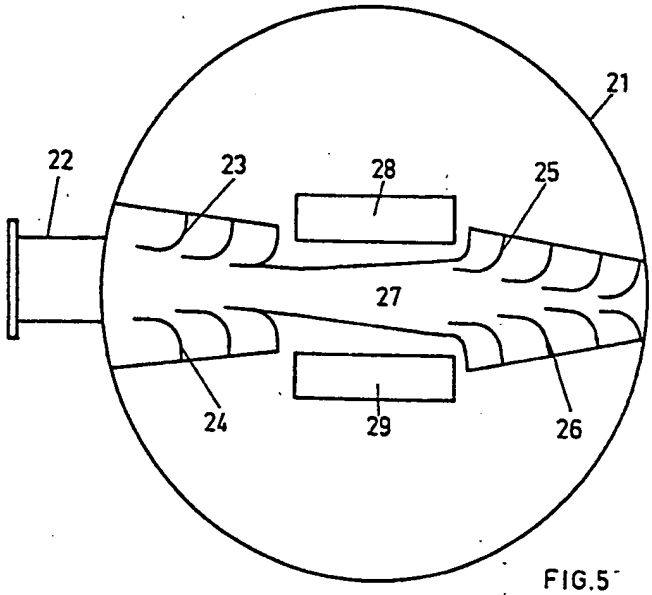

FIG.5

1119699 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 2 & 3

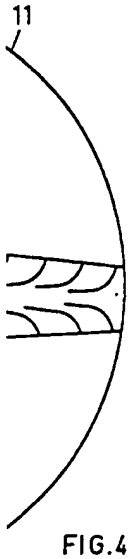

FIG.4

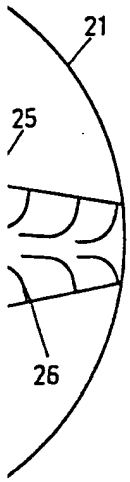

FIG.5

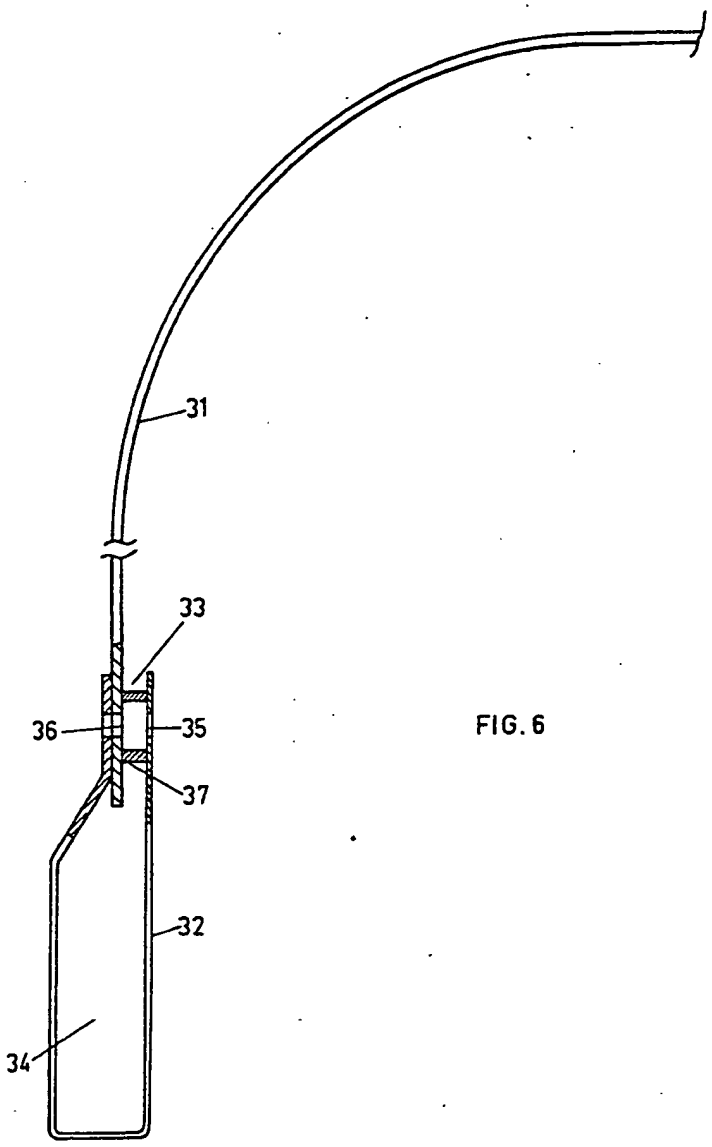

FIG. 6

1119699 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 2 & 3

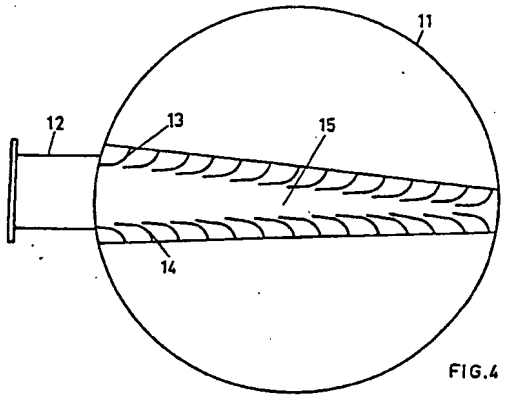

FIG.4

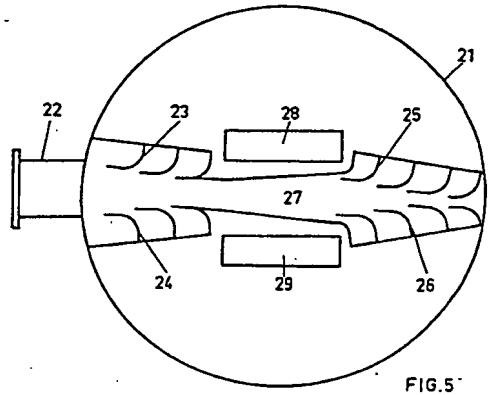

FIG.5

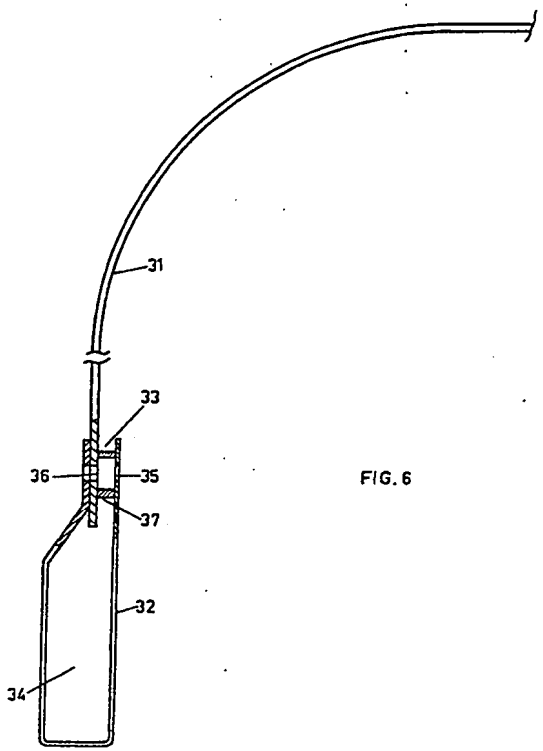

FIG. 6